NASA Research to Support the Airlines

Richard Mogford, Ph.D.
NASA Ames Research Center

Examples of NASA Aeronautics Projects

- Airline Operations Workshop
- NASA/Airline industry forum
- Flight Awareness Collaboration Tool
- Dispatcher human factors study
- Airline Operations Research Group
- Infrasound-based turbulence detection
- Incursion detection in aircraft safety zone
- Dynamic Weather Routes
- Traffic Aware Strategic Aircrew Requests

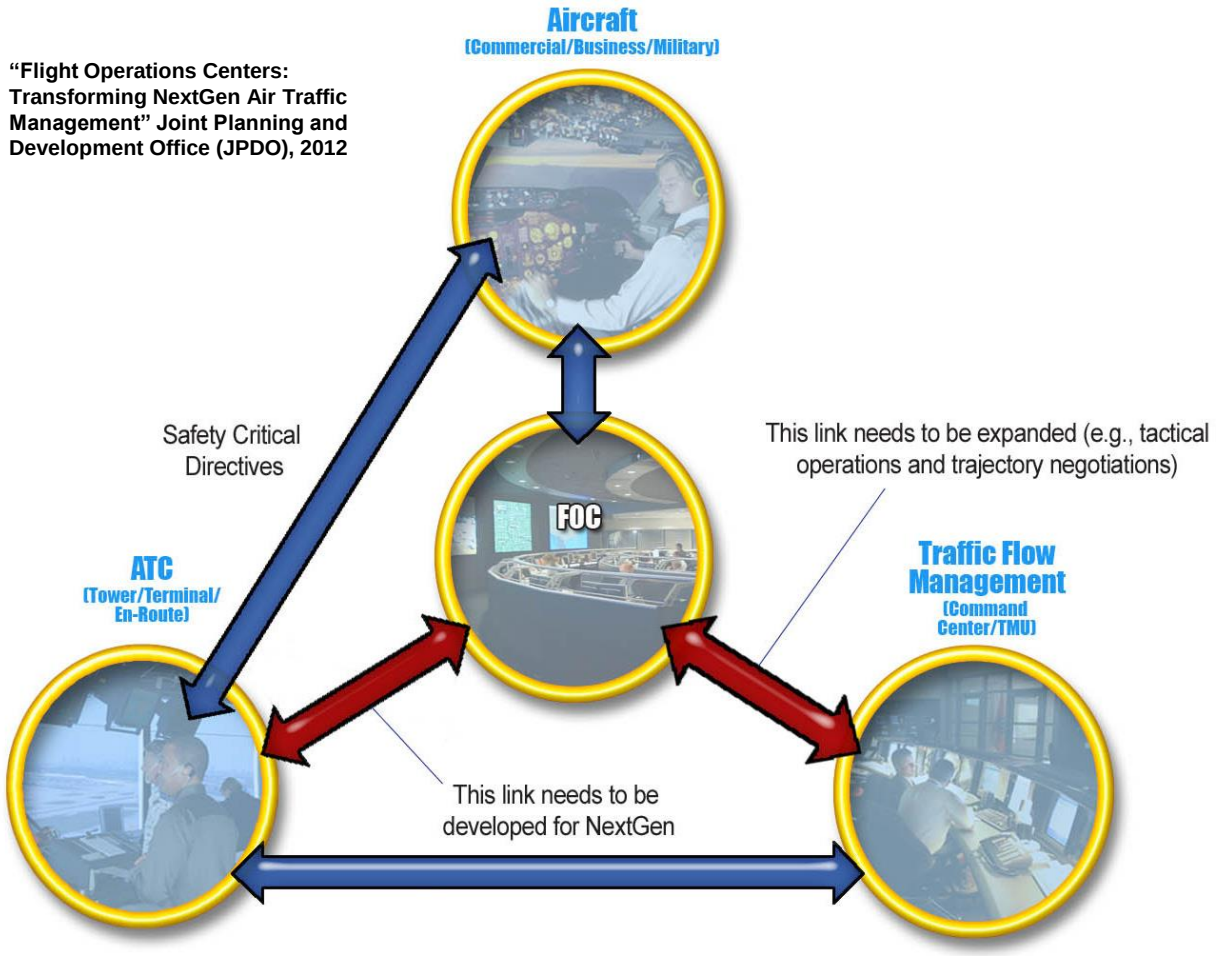
Airline Operations Workshop

- Held an Airline Operations Workshop at NASA Ames in August 2016
  - About 200 attendees - airlines and airline software vendors, NASA, FAA, and academia
  - Focused on NASA, FAA, and private sector innovations to support the airlines (AOC and flight deck)
  - Identified gaps where research is needed
  - Formed partnerships with airline industry
- Research themes
  - AOC simulation
  - Study dispatcher workload, situation awareness, errors
  - Display/system integration
  - Managing/accessing large information databases from multiple sources
  - Preferred routes

AOC = airline operations center

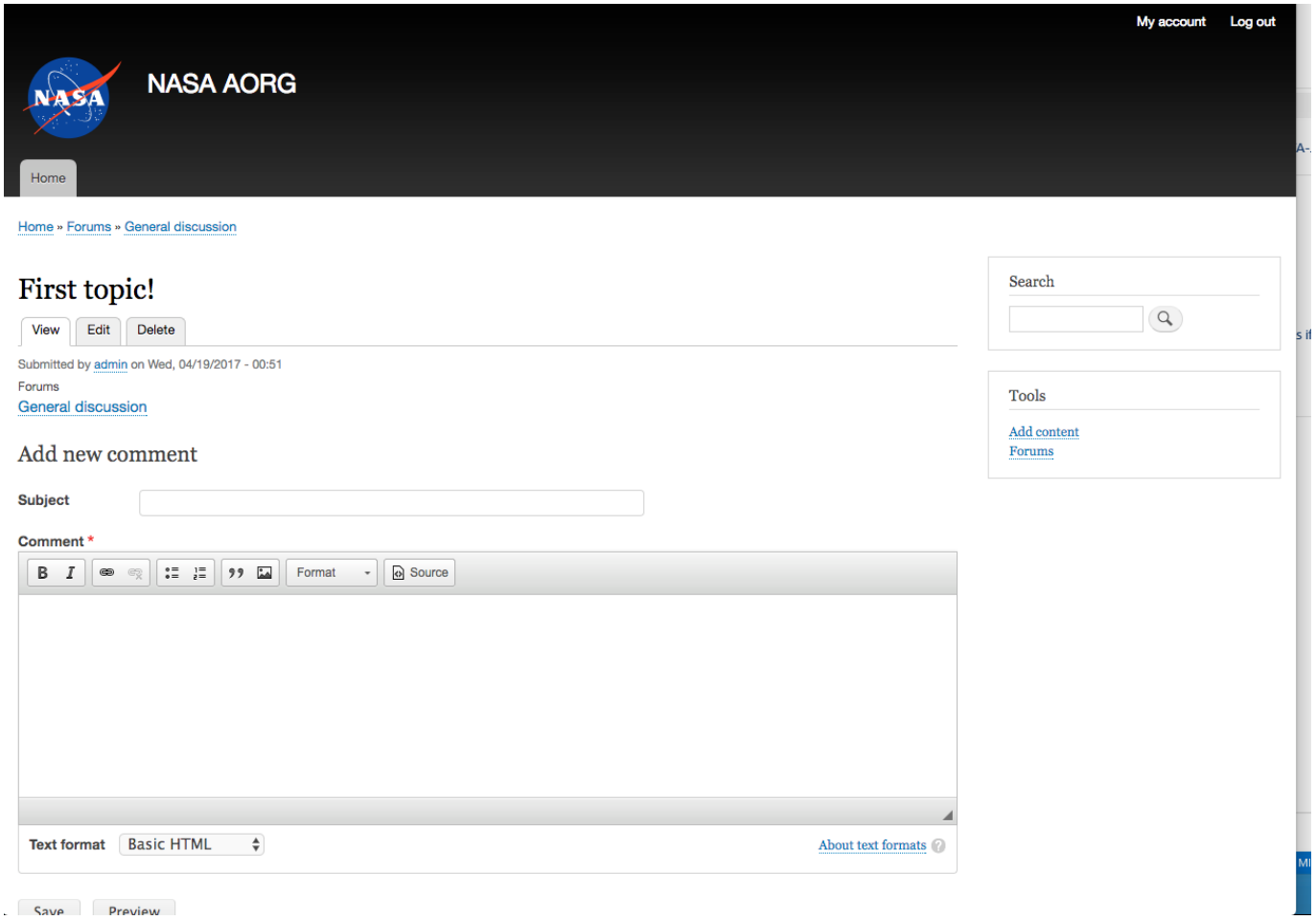
Emphasis on Airline Operations

"Flight Operations Centers: Transforming NextGen Air Traffic Management" Joint Planning and Development Office (JPDO), 2012



FOC = flight operations center

NASA/Airline Industry Forum

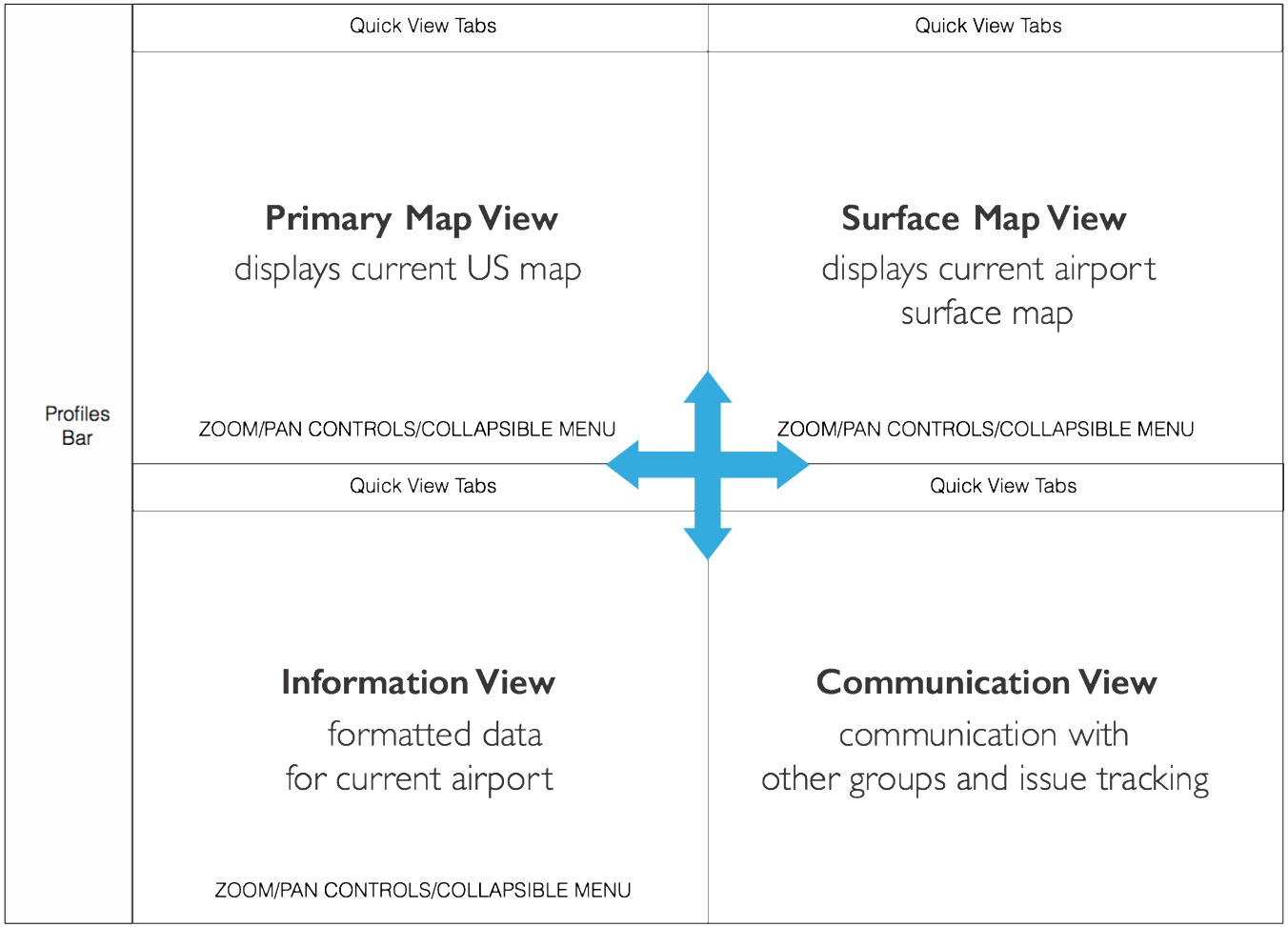


Being created to support airline industry and NASA technical discussions

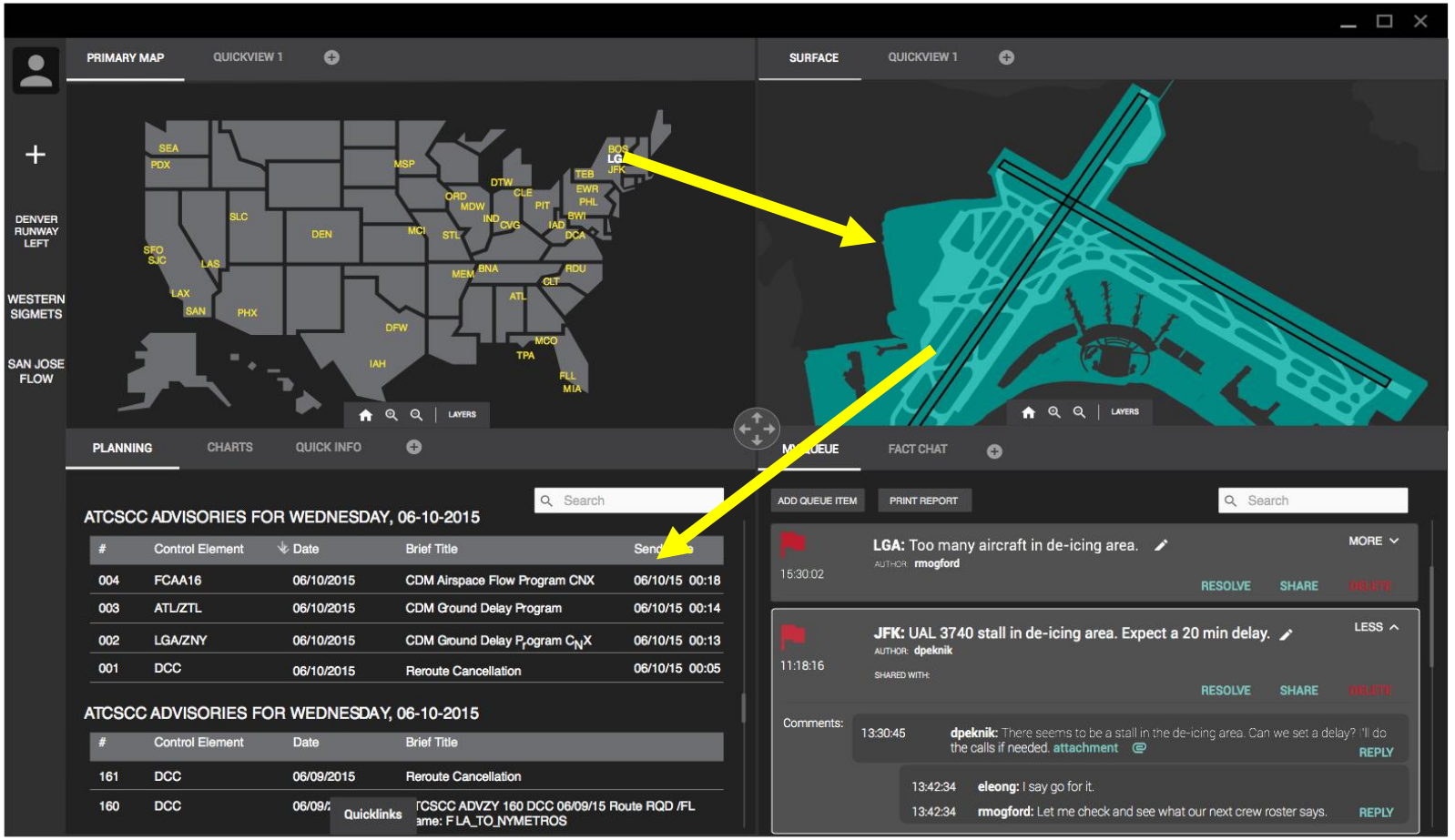
Flight Awareness Collaboration Tool

- Developing the “Flight Awareness Collaboration Tool” (FACT)
- Concentrates information about winter weather events on one display
- Includes predictive tools
- Supports collaboration between AOC, air traffic control, airport authority, and de-icing operators
- Web-based application
- Includes:
  - Weather status and forecasts
  - FAA Winter Weather Dashboard
  - Prediction/reporting of runway closures for snow/ice treatment
  - Runway braking action
  - Airport runway configuration (capacity)
  - De-icing operations
  - FAA actions (e.g., ground stops, miles-in-trail, etc.)

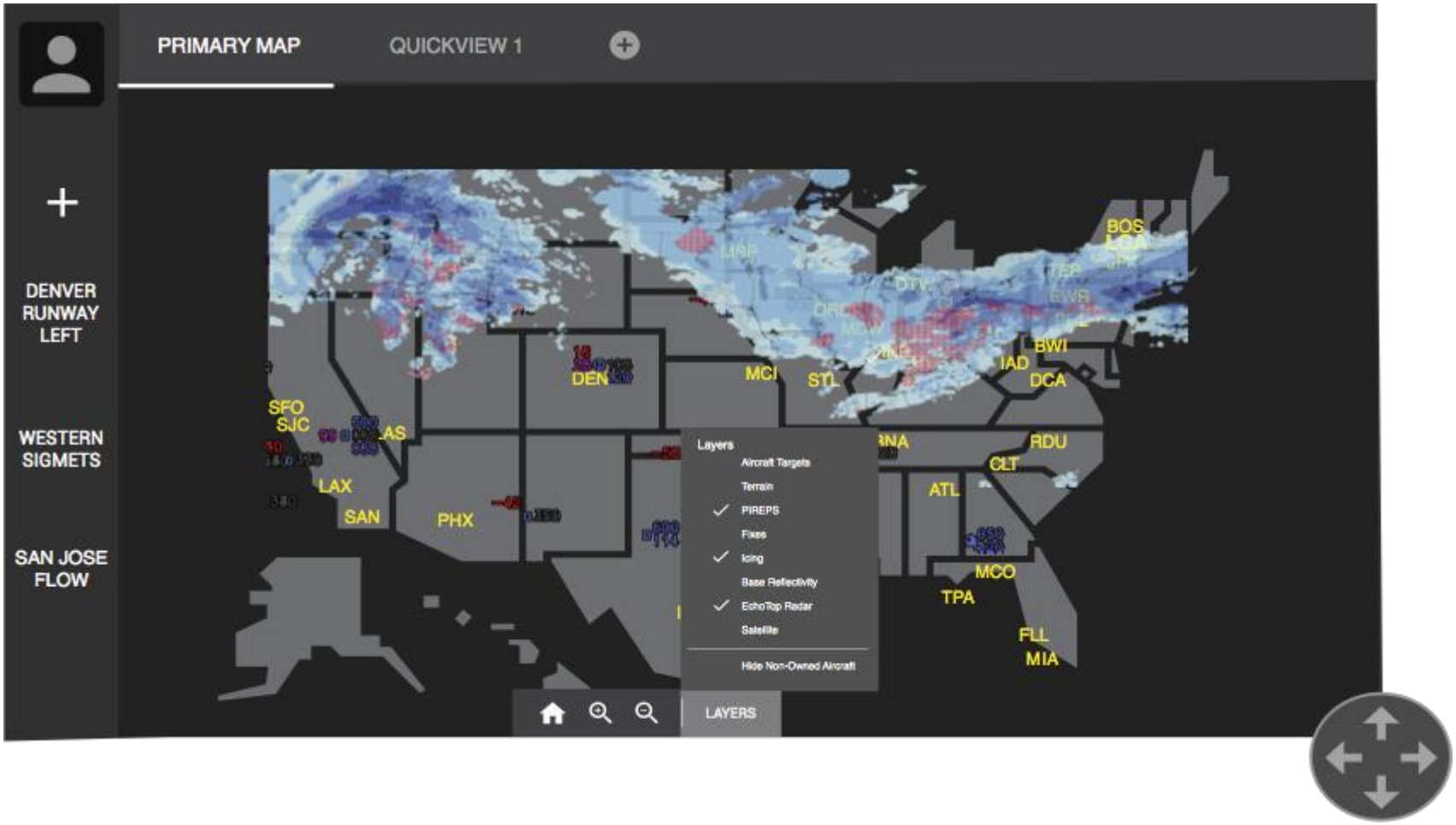
FACT Design


Profiles Bar
Quick View Tabs
Quick View Tabs
Primary Map View
displays current US map
Surface Map View
displays current airport surface map
ZOOM/PAN CONTROLS/COLLAPSIBLE MENU
ZOOM/PAN CONTROLS/COLLAPSIBLE MENU
Quick View Tabs
Quick View Tabs
Information View
formatted data for current airport
Communication View
communication with other groups and issue tracking
ZOOM/PAN CONTROLS/COLLAPSIBLE MENU

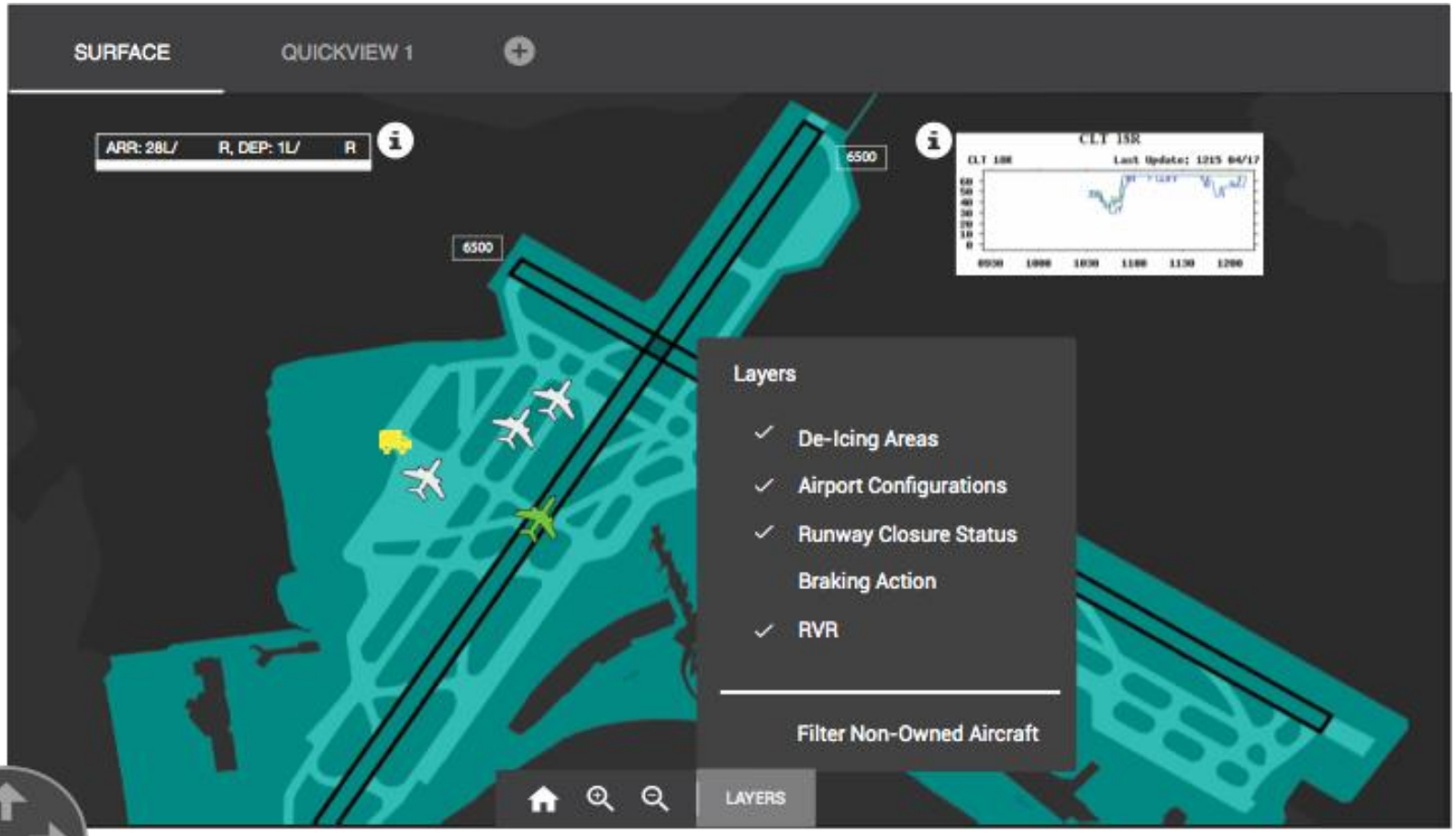
FACT User Interface



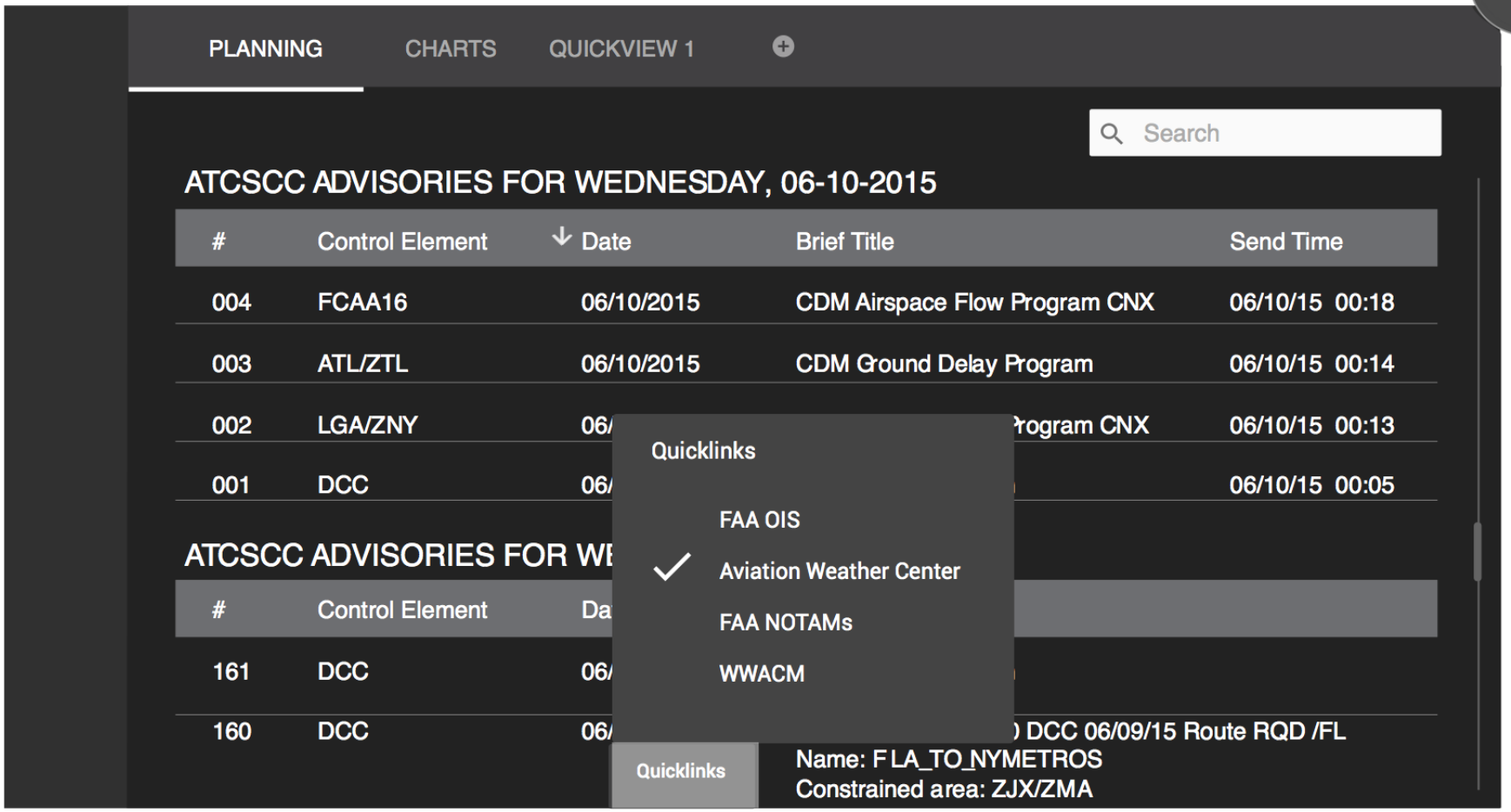
FACT Primary Map View



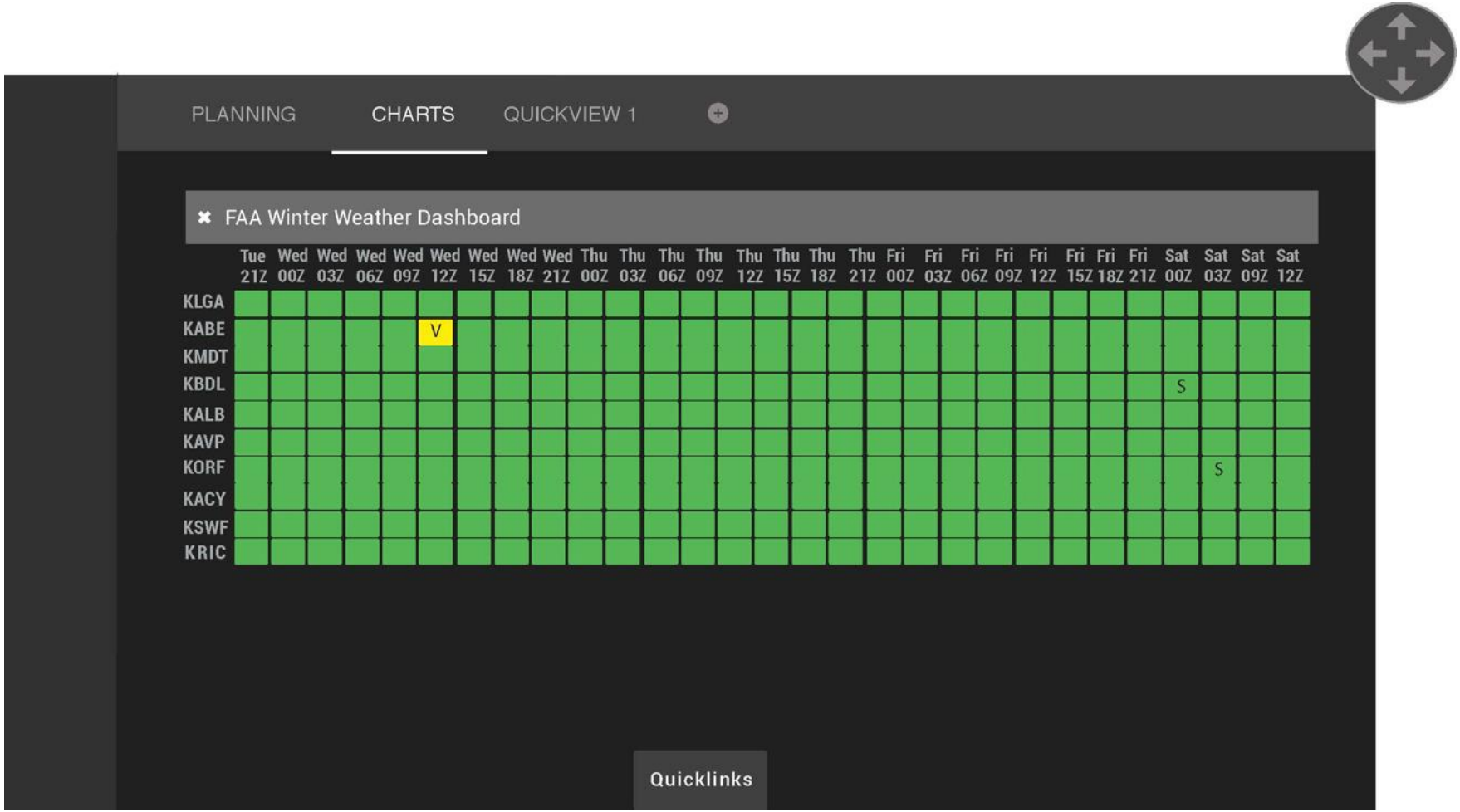
FACT Surface Map View



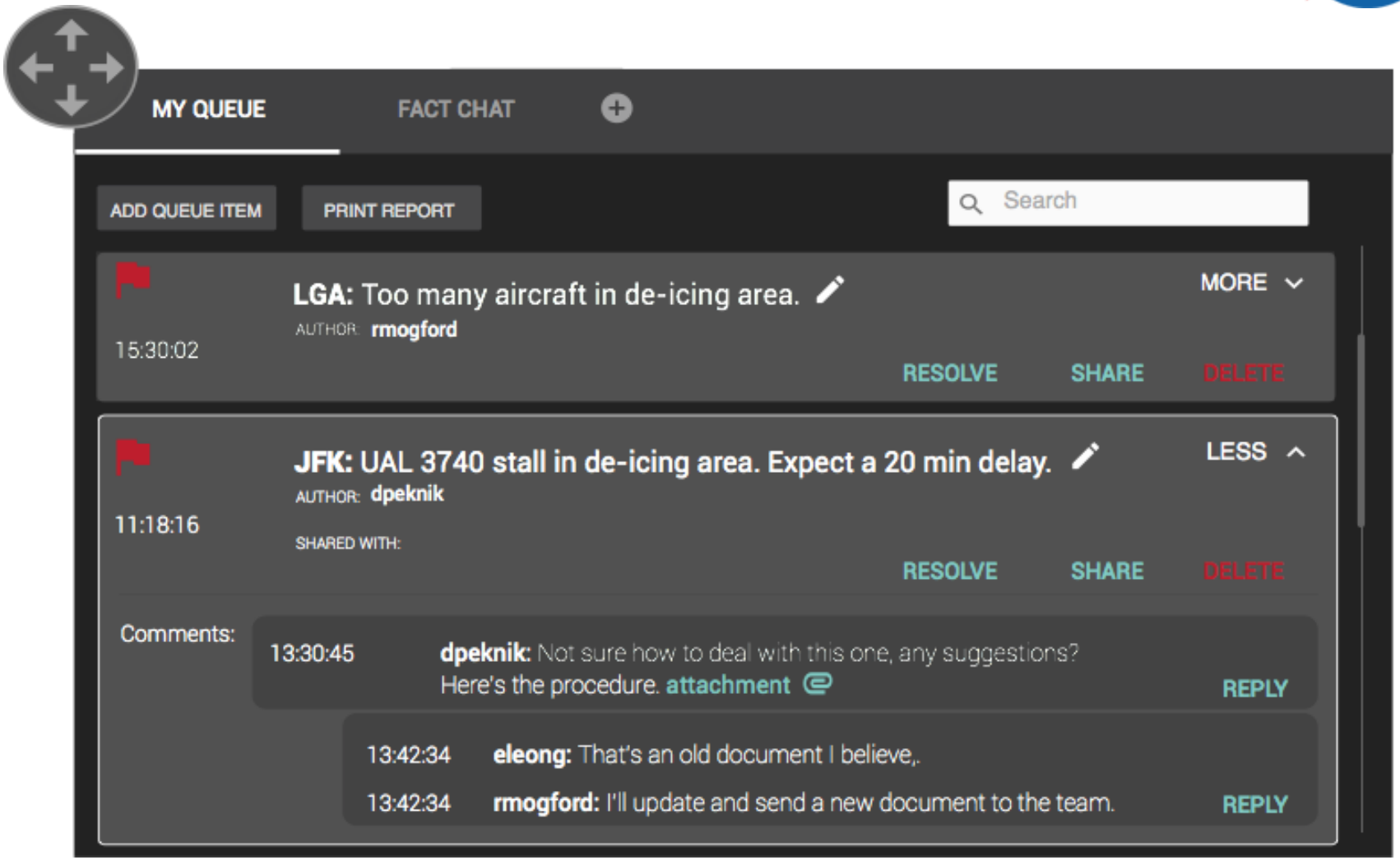
FACT Information View (Text)



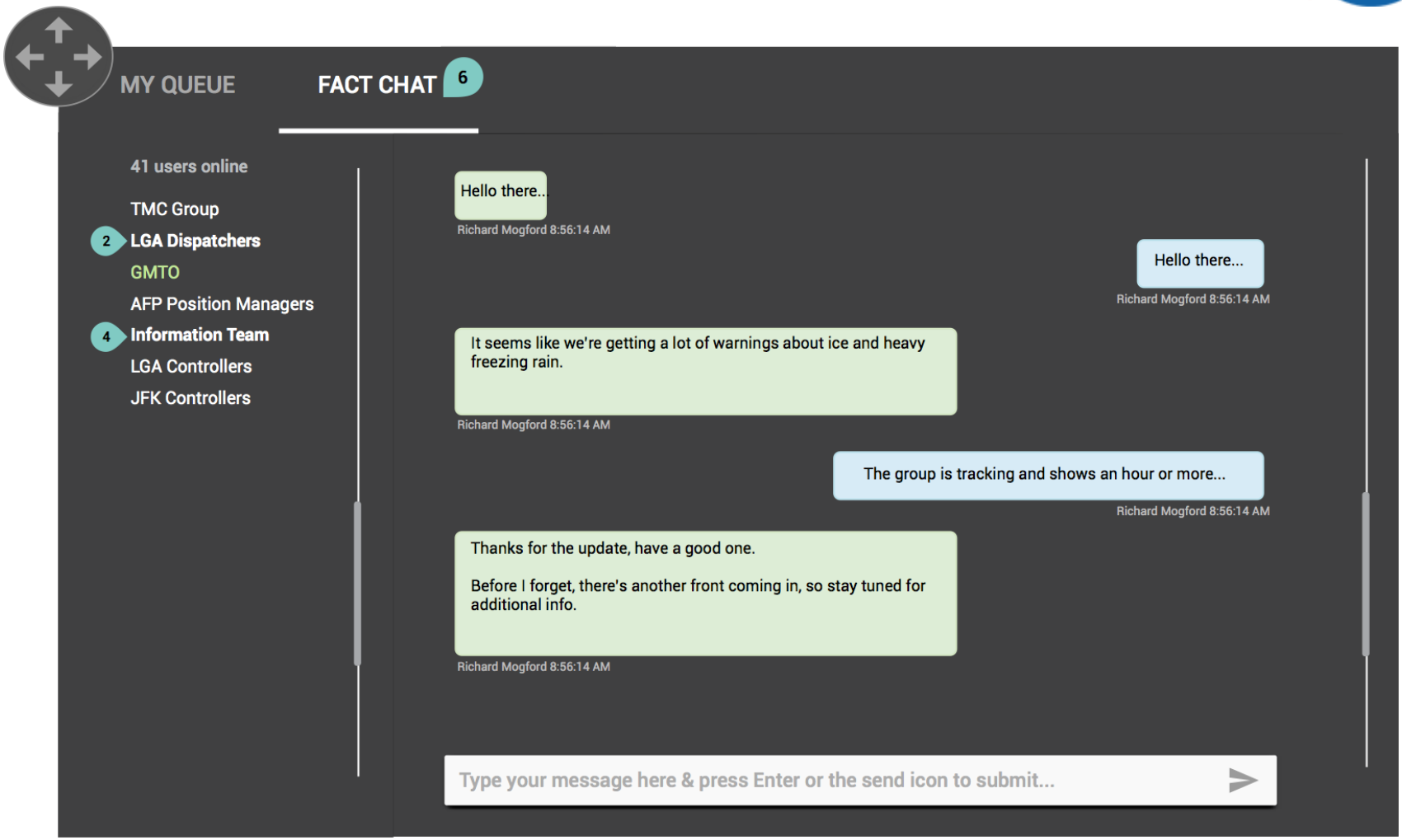
FACT Information View (Graphics)



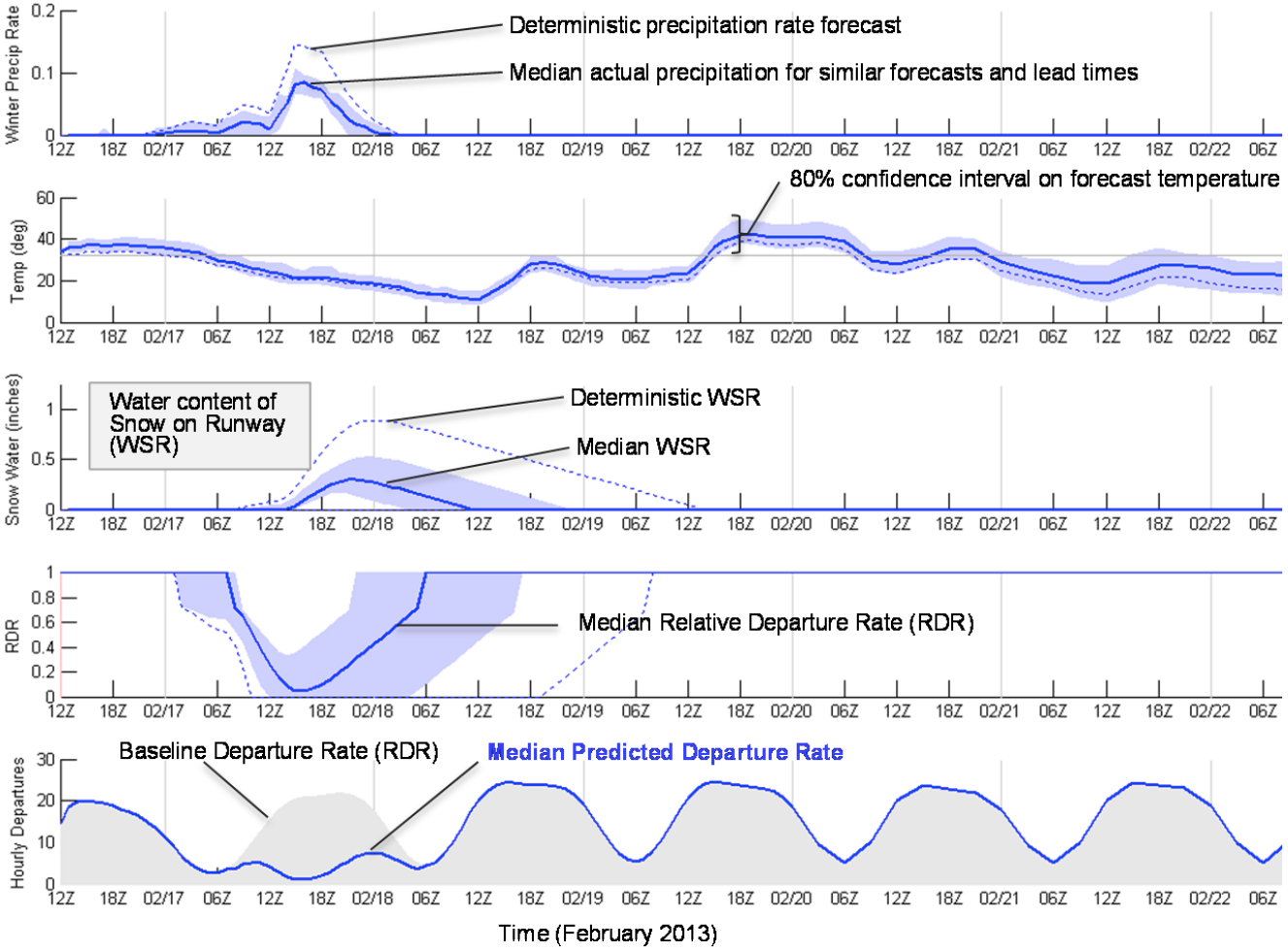
FACT Communication View



FACT Communication View



Winter Weather Airport Capacity Model



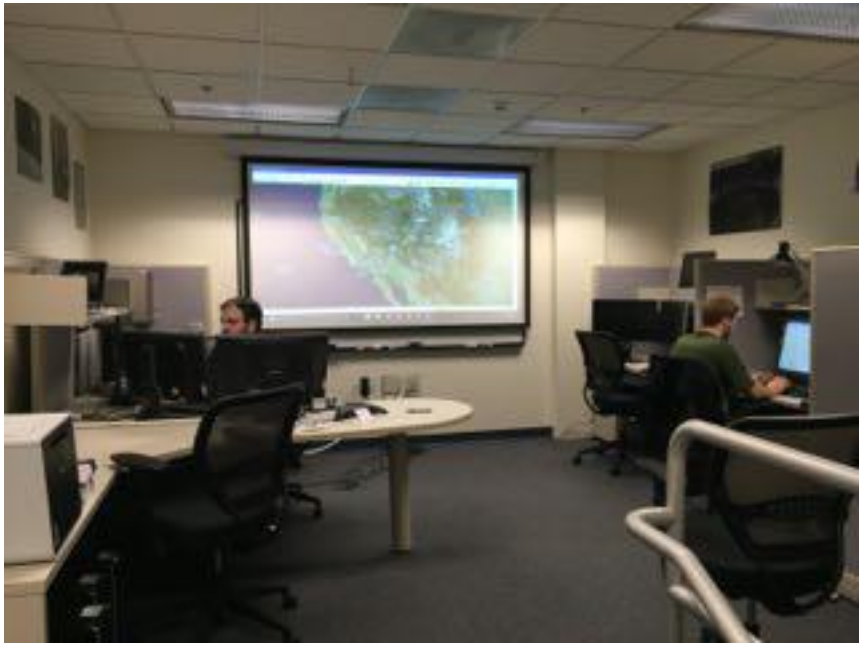
FACT Status

- User interface design completed and web-based prototype under development
- Winter Weather Airport Capacity Model being evaluated at several facilities
- User group at Detroit airport
- Plan to begin showing FACT to potential users to request feedback on functionality and user interface design
- Will visit US airlines to review FACT and other research issues

Dispatcher Human Factors Study

- Suggestions for a human factors study of dispatcher tasks at the Airline Operations Workshop
- Partnering with two major airlines
- Will visit AOCs to shadow dispatchers during various shifts across several days
- Trying to better understand the work of dispatchers in several configurations
  - Extended operations flights
  - Transcontinental flights
  - Weather events
- Will provide a basis for more detailed studies and better informed research

Airline Operations Research Group

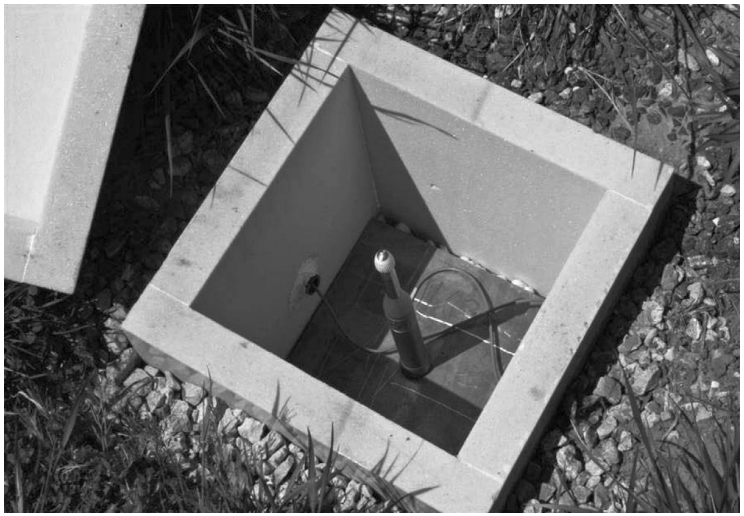


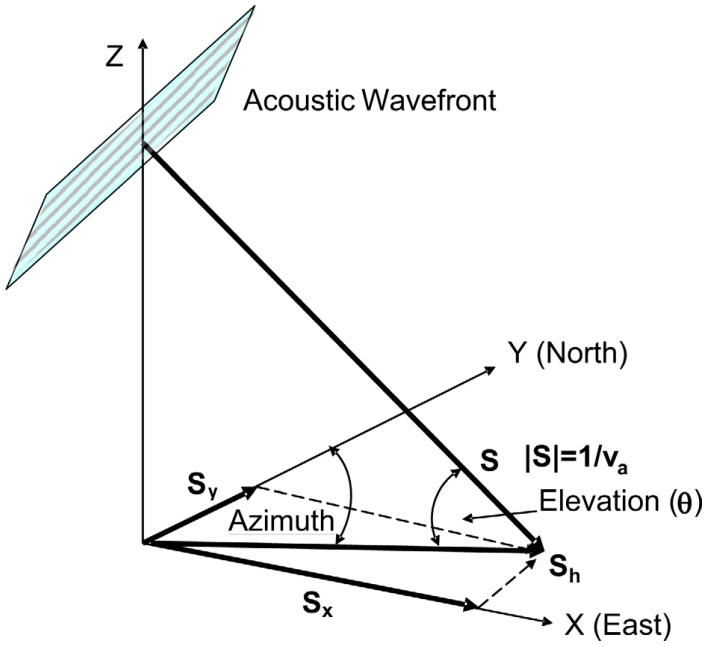
Laboratory created at NASA Ames

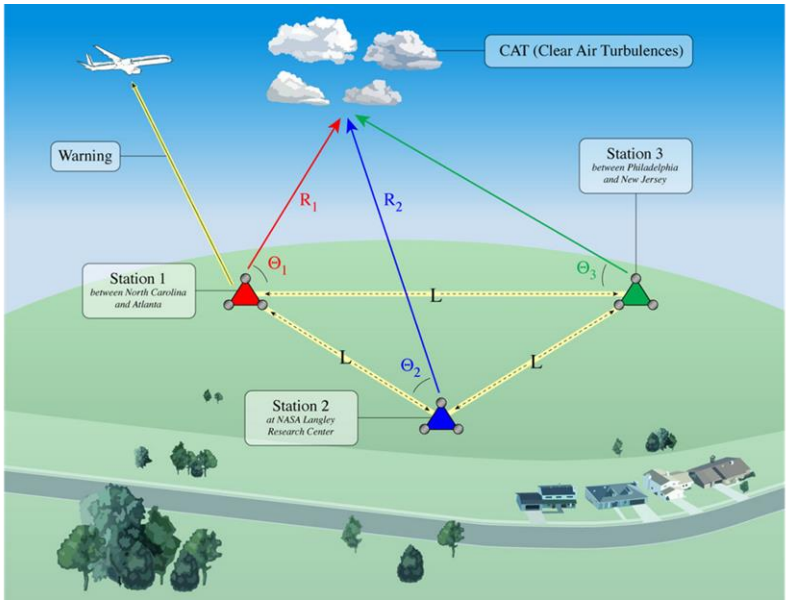
Infrasound-based Turbulence Detection Feasibility Study

- Partnering with University Corporation for Atmospheric Research to determine if clear air turbulence detection by infrasonic microphone arrays is feasible
- Study objectives:
  - What are the spectral characteristics of the acoustic energy?
  - How are the spectral characteristics of the acoustic energy related to turbulence intensity metrics that, in turn, can be related to aircraft response?
  - What are the transmission properties of the acoustic signal (i.e., attenuation, refraction, and diffraction) as the acoustic waves propagate from the source to the receivers?
  - Given the proposed geometries of a receiver array, what are the temporal and spatial accuracies that can be achieved?
  - What are the appropriate signal processing methods to ensure adequate detection and minimal false alarms?
- Dr. Qamar Shams at NASA Langley has an infrasound array set up
  - Second array needed to test localization

Acoustic Array



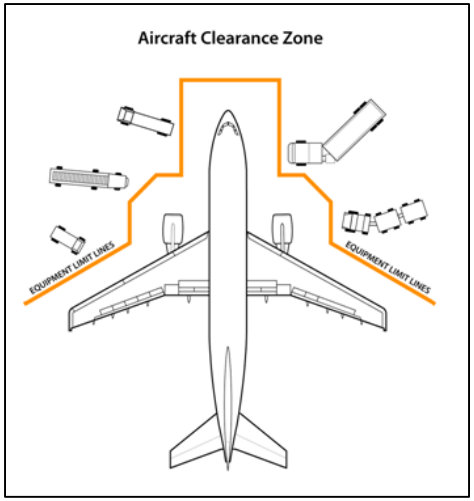




Microphone Array and Detection Example

Incursion Detection in Aircraft Safety Zone

- How to reduce ground vehicle incidents?
  - Will analyze ramp area video recordings provided by partner airlines
  - Determine if ground vehicle incursion into aircraft safety zone can be reliably detected



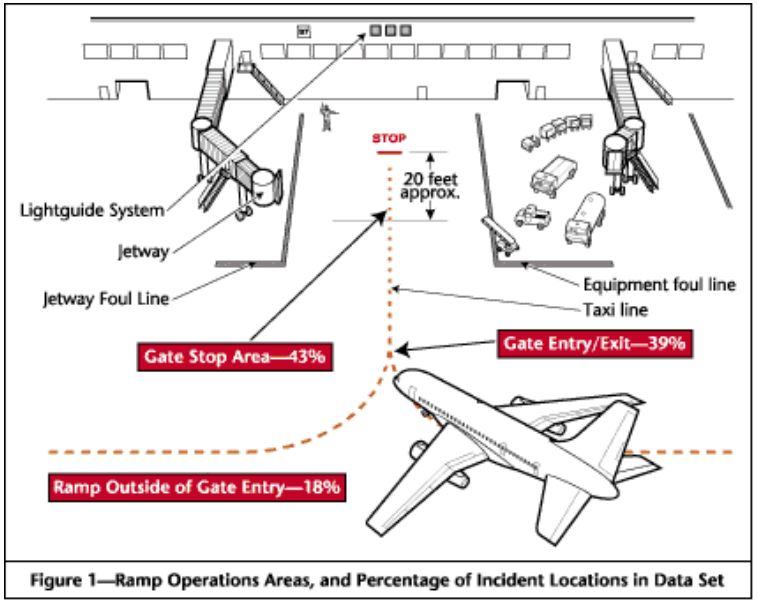


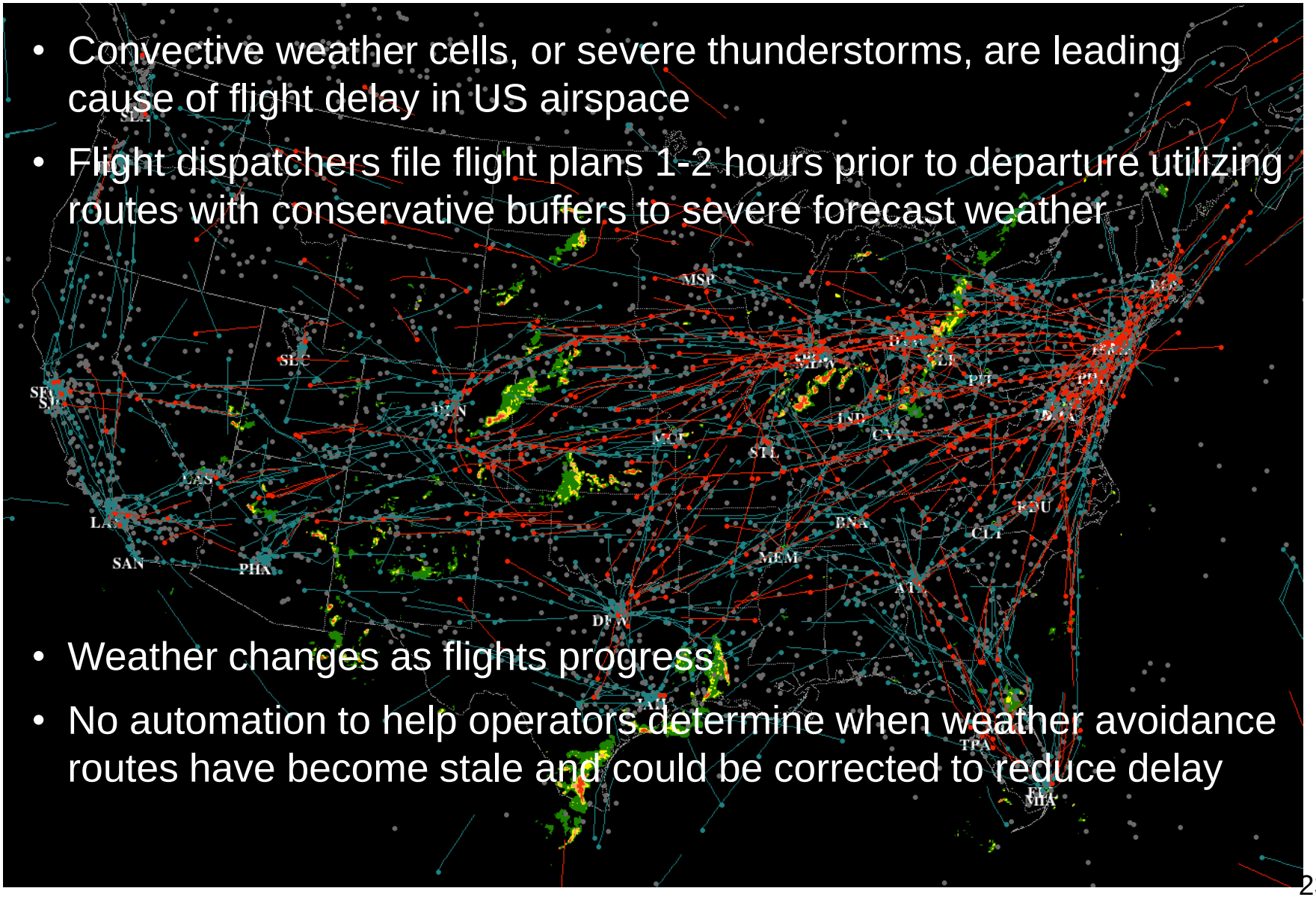
Figure 1—Ramp Operations Areas, and Percentage of Incident Locations in Data Set

Incursion Detection in Aircraft Safety Zone

Dynamic Weather Routes (DWR)

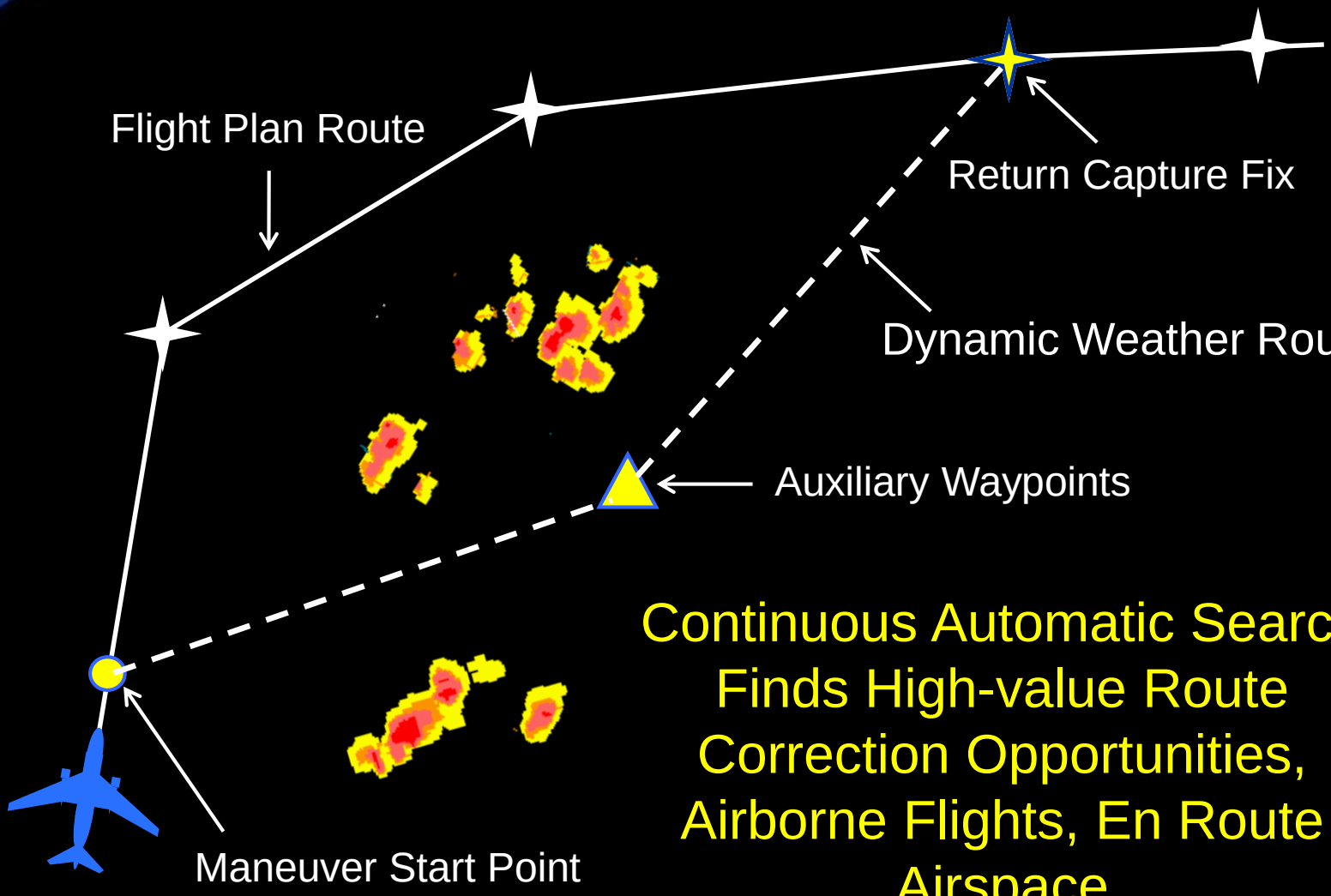
What's the Problem?

- Convective weather cells, or severe thunderstorms, are leading cause of flight delay in US airspace
- Flight dispatchers file flight plans 1-2 hours prior to departure utilizing routes with conservative buffers to severe forecast weather



- Weather changes as flights progress
- No automation to help operators determine when weather avoidance routes have become stale and could be corrected to reduce delay

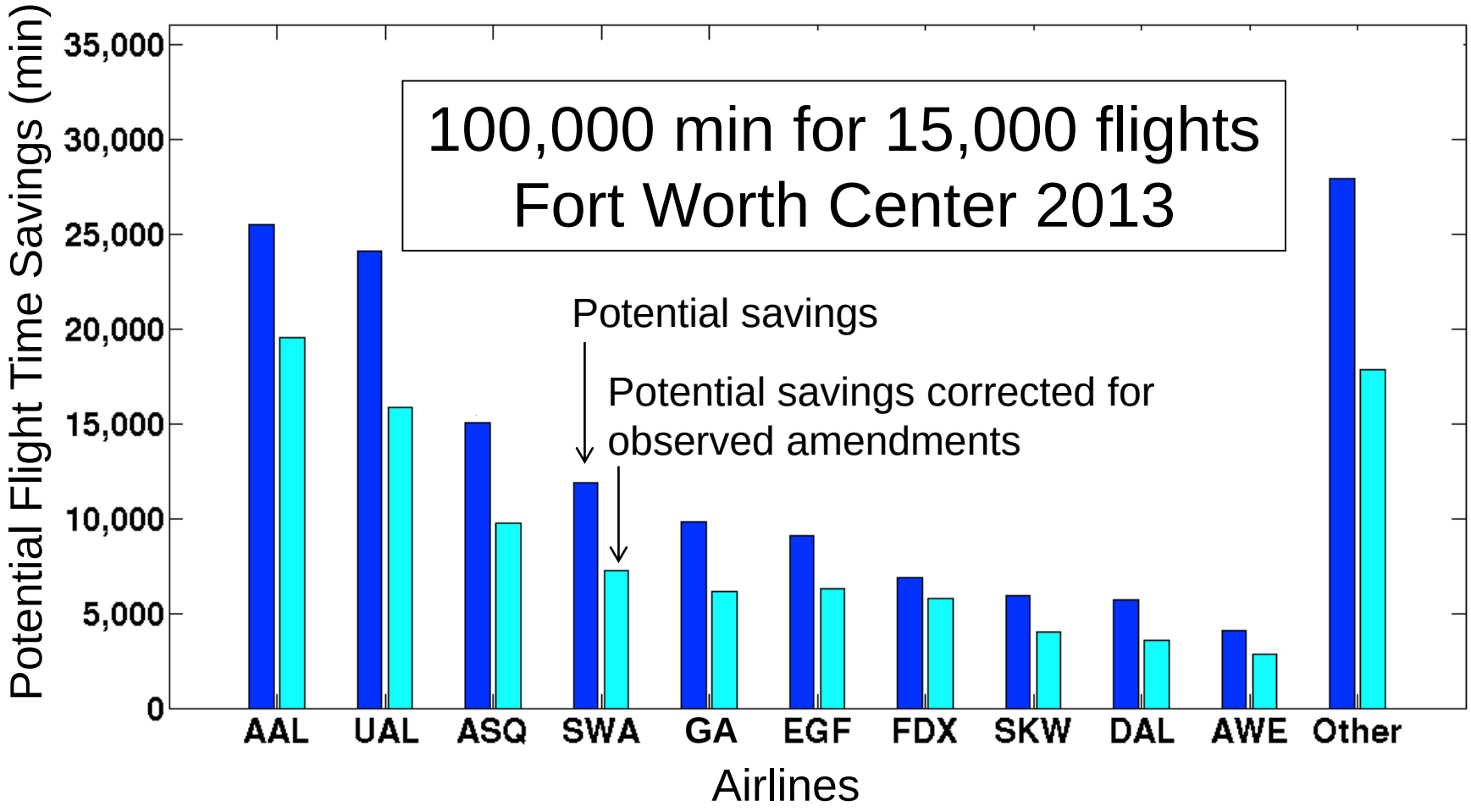
DWR



Continuous Automatic Search Finds High-value Route Correction Opportunities, Airborne Flights, En Route Airspace

Potential Benefits Analysis

All Airlines, All Flights, Fort Worth Center 2013

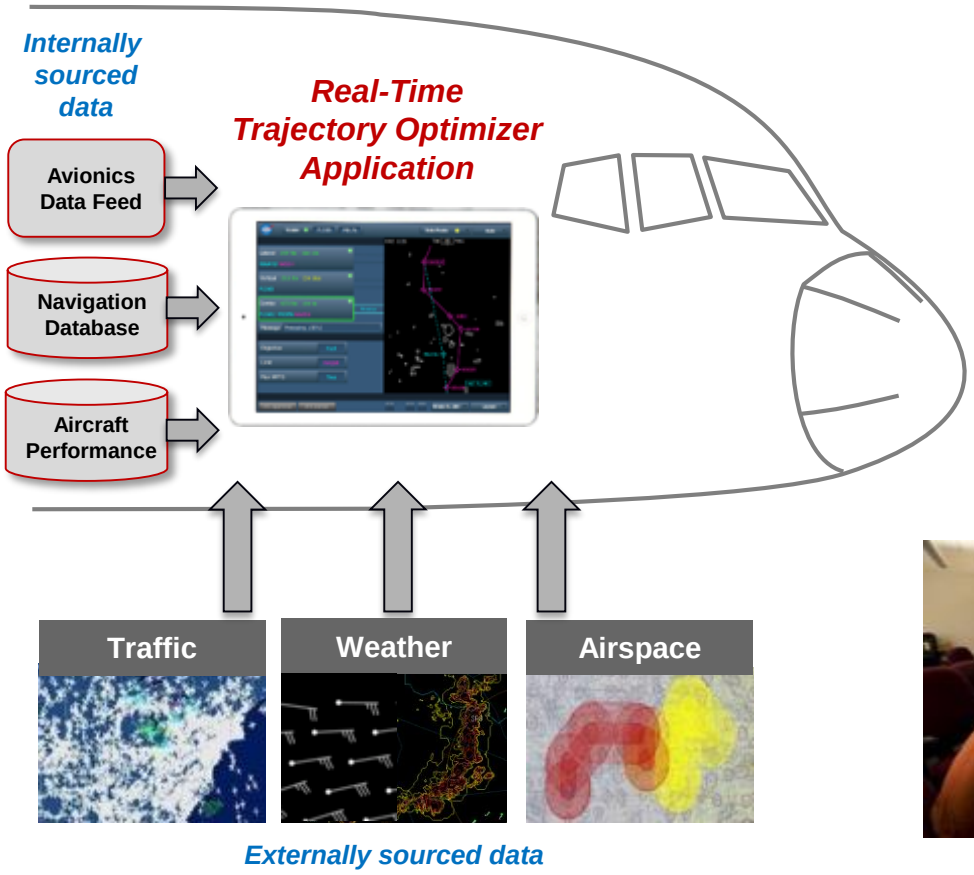


Traffic Aware Strategic Aircrew Requests (TASAR) NASA Flight Deck Application for En Route Flight Optimization

David Wing, TASAR Principal Investigator
NASA Langley Research Center
david.wing@nasa.gov

TASAR Design

Enhanced User Request Process leveraging Cockpit Automation and Networked Connectivity to real-time operational data to optimize an aircraft's trajectory en route



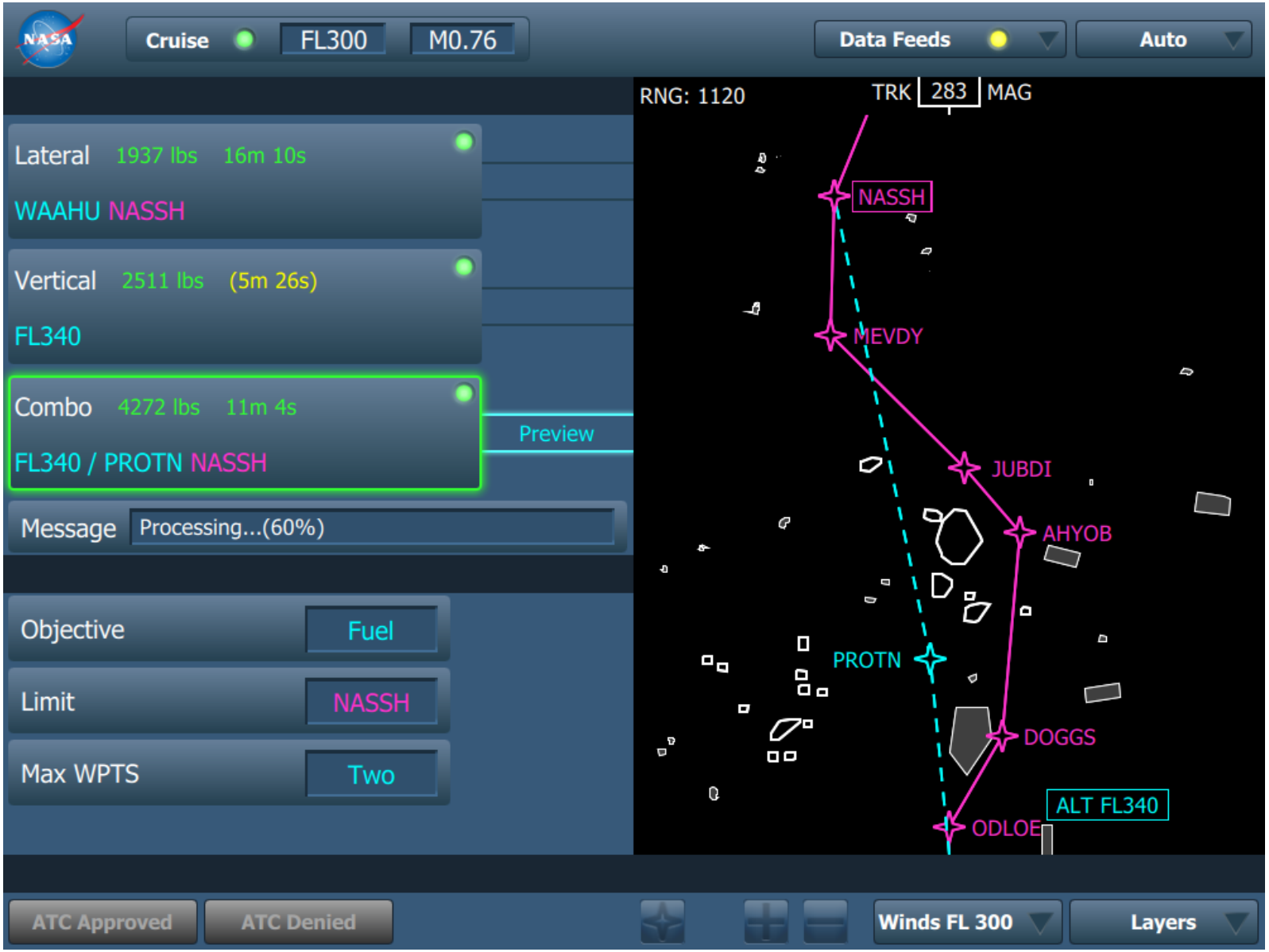
Increased flight efficiency

Enhanced ATC request/ approval process

Enhanced dispatch/aircrew coordination

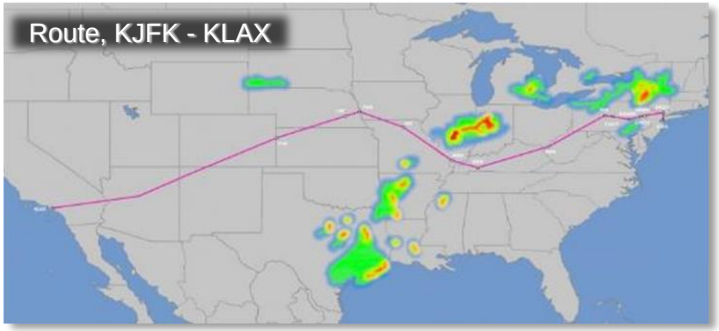
ATC = air traffic control

Traffic Aware Planner (TAP) Auto Mode



Simulation Experiments

Aug 2013, Oct-Nov 2014



- *Fixed-based commercial transport simulator*
- *24 pilots (left seat, pilot flying)*
- *2 simulated flights each, 5-6 use cases*
- *Two HMI designs (separate simulations)*

- *Rigorous human factors experimental design*
- *Evaluated normal and non-normal flight conditions*

Objectives

1. Assess TASAR effect on workload
2. Assess potential interference with primary flight duties
3. Assess TAP HMI design update
4. Assess CBT effectiveness

Results

1. ***No effect on pilot workload compared to standard flight-deck baseline condition***
2. ***Non-normal event response not adversely affected***
3. ***TAP useful, understandable, intuitive, easy to use***
4. ***Standalone CBT was as effective as live instructor***

Two flight trials also completed

HMI = human machine Interface
CBT = computer based trainer
U.I. = Operator Performance Lab, Univ. of Iowa


National Aeronautics and Space Administration
NASA
Questions?
richard.mogford@nasa.gov